Venus Suface Sampling and Analysis

Completed Technology Project (2015 - 2018)

Project Introduction

This effort is developing the technology to transfer particulate samples from a Venus drill (being developed by Honeybee Robotics in a Phase 2 Small Business Innovative Rearch task) inside the lander pressure vessel and thermal barrier and to present them to instruments for analysis under Earth-like temperature and low pressure environment.

The overall objective of this task is to develop a Venus surface sample acquisition and transfer system that can reliably provide particulate samples of sufficient quantity and presentation location for instruments located inside the lander to perform useful analysis. Development priority was given to the high-temperature, high-pressure external functions and the transition element between external high-pressure, high-temperature conditions and the internal low-pressure, room-temperature conditions where the instruments will operate, because that is where most of the mission risk resides. Fortunately, JPL has partnered with Honeybee Robotics on the Venus lander mission concept and they have already developed prototypes of a rotary drill, electric actuators and a gear box that operate at high temperatures. Honeybee has further matured their technology in this, the first of two years of a separate Phase 2 SBIR task. The JPL strategy for this R&TD proposal is to focus on component and subsystem technology development to provide the other required functions of the overall system. Development in this sense consists of design, fabrication and successful testing of prototype hardware under a relevant environment (TRL 5).

The guiding philosophy of this effort has been to expand beyond the Soviet Venera sampling solution that was limited to a single sample from a single drill delivered to a single instrument in a lander resting on flat (<10° slope) terrain. In particular, there is a strong desire to be able to accommodate two instruments such as an infrared spectrometer and an X-ray fluorescence spectrometer for mineralogical and elemental abundance analyses, and to present the surface samples in a benign environment to minimize the need for adaptation of these instruments for use at Venus. We accepted this premise and made other assumptions in this task, understanding full well that mission trades may require ongoing adaptation of the sample system development as trades are closed and decisions made.

The quantitative capability goal is that two particulate samples of at least 10 g each would be provided for analysis by two instruments either as soil/dirt from the surface or as cuttings created during the sample excavation process. The sample measurement environment would be low temperature (notionally 30°C) and low pressure (< 1 atm). It is assumed that one sample would be from the weathered surface material at a depth of 0-2 cm and the second from presumably unweathered material (if drilled from competent rock) at a depth of 2-4 cm. The sampling system is designed to accommodate a wide range of surface material hardness from loose soil to basalt (7-8 on the Moh scale).

JPL_IRAD_Activities Project

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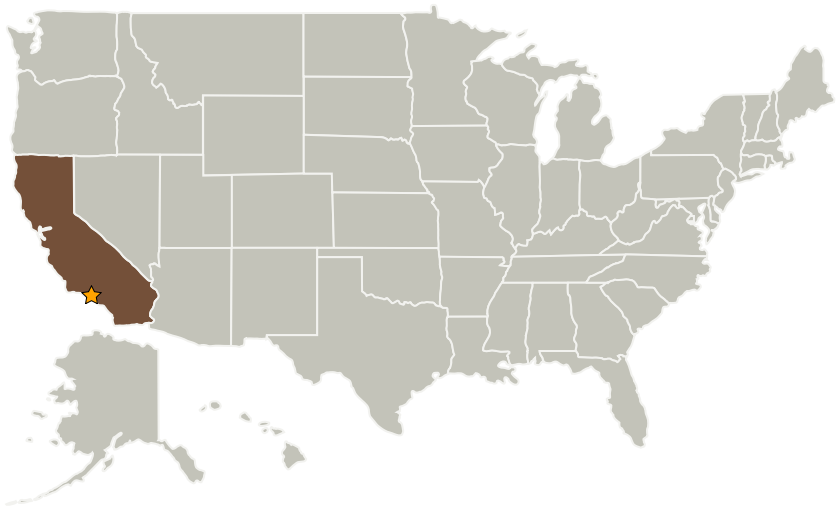
Anticipated Benefits

For over 30 years, no Venus mission has made any in-situ measurements of the Venus atmosphere or surface. NASA's only mission to Venus that included a planetary probe, the Pioneer-Venus Multiprobe mission, was launched in August 1978, and the final Soviet Venus surface mission, VEGA-2, landed in 1985.

In the most recent Planetary Decadal Survey, "Vision and Voyages for Planetary Science in the Decade 2013-2022," a Venus In Situ Explorer (VISE) mission was identified as one of the five recommended candidates for the upcoming NASA New Frontiers 4 mission competition. JPL has previously proposed the SAGE Venus lander mission concept during New Frontiers 2 and 3 (NF-2 and NF-3), and progressed as far as Step 2 (Phase A) during the NF-3 competition. However, both prior attempts received major weaknesses for the proposed surface sample measurement approach and therefore JPL needs to formulate and develop an improved approach. The research proposed here supports that goal by developing critical component and subsystem technology for a bring-the-sample-inside the lander architecture option.

This task has demonstrated that drill cuttings can be effectively transported by Venus atmospheric pressure to a sample analysis window. This task is ready to demonstrate that this sample and window can be moved between Venus pressure and normal Earth conditions (~20C and <1 bar) for analysis by instruments that have not been re-engineered for Venus conditions. This task has demonstrated that a NAGRS instrument can significantly improve over the analysis uncertainties achieved in the Soviet missions decades ago.

Primary U.S. Work Locations and Key Partners



Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Jet Propulsion Laboratory (JPL)

Responsible Program:

Center Independent Research & Development: JPL IRAD

Project Management

Program Manager:

Fred Y Hadaegh

Project Manager:

Fred Y Hadaegh

Principal Investigator:

Brian H Wilcox

Co-Investigators:

James L Lambert
Joseph P Melko

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Organizations Performing Work	Role	Type	Location
★Jet Propulsion Laboratory(JPL)	Lead Organization	NASA Center	Pasadena, California

Co-Funding Partners	Type	Location
Honeybee Robotics, Ltd.	Industry	Pasadena, California

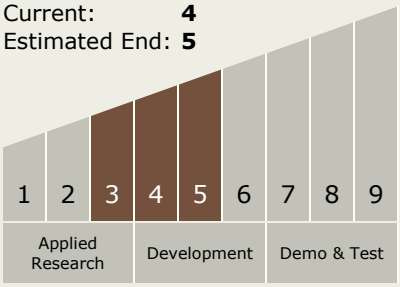
Primary U.S. Work Locations
California

Images

JPL_IRAD_Activities Project Image
JPL_IRAD_Activities Project
(https://techport.nasa.gov/image/28006)

Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **5**



Technology Areas

Primary:

- TX04 Robotic Systems
  - TX04.3 Manipulation
    - TX04.3.4 Sample Acquisition and Handling

Target Destination

Others Inside the Solar System

Supported Mission Type

Push